Coastal Wave Studies
FY13 Summary Report

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LONG-TERM GOALS

Our long-term goal is to make significant advances to coastal and nearshore wave modeling through improved understanding of coastal and nearshore wave transformation processes.

OBJECTIVES

The objectives of this study are to

1. Make high-fidelity measurments of wave transformation processes in the nearshore and coastal zones. Provide high-quality test cases for model development and evaluation
2. Contribute to the improvement of WaveWatch III and SWAN through the integration of a state-of-the-art wave partitioning and swell system tracking technology
3. Develop and apply robust wave model assessment technology for community use (USACE in-kind support)

APPROACH

Wave observations.

USACE has developed, implemented and maintained a cross-shelf array of meteorological, directional wave and vertical current sensors suitable for capturing all phases of wave transformation across the continental shelf and through the nearshore zone. The nearshore array configuration is depicted in Figure 1. Also included are directional waverider buoys at 17- and 26-m depths and NDBC station 44014 at 95-m depth. As data are collected, we are extracting a variety of events (pure wind sea, pure swell, mixed seas, etc) to use as model development test cases.

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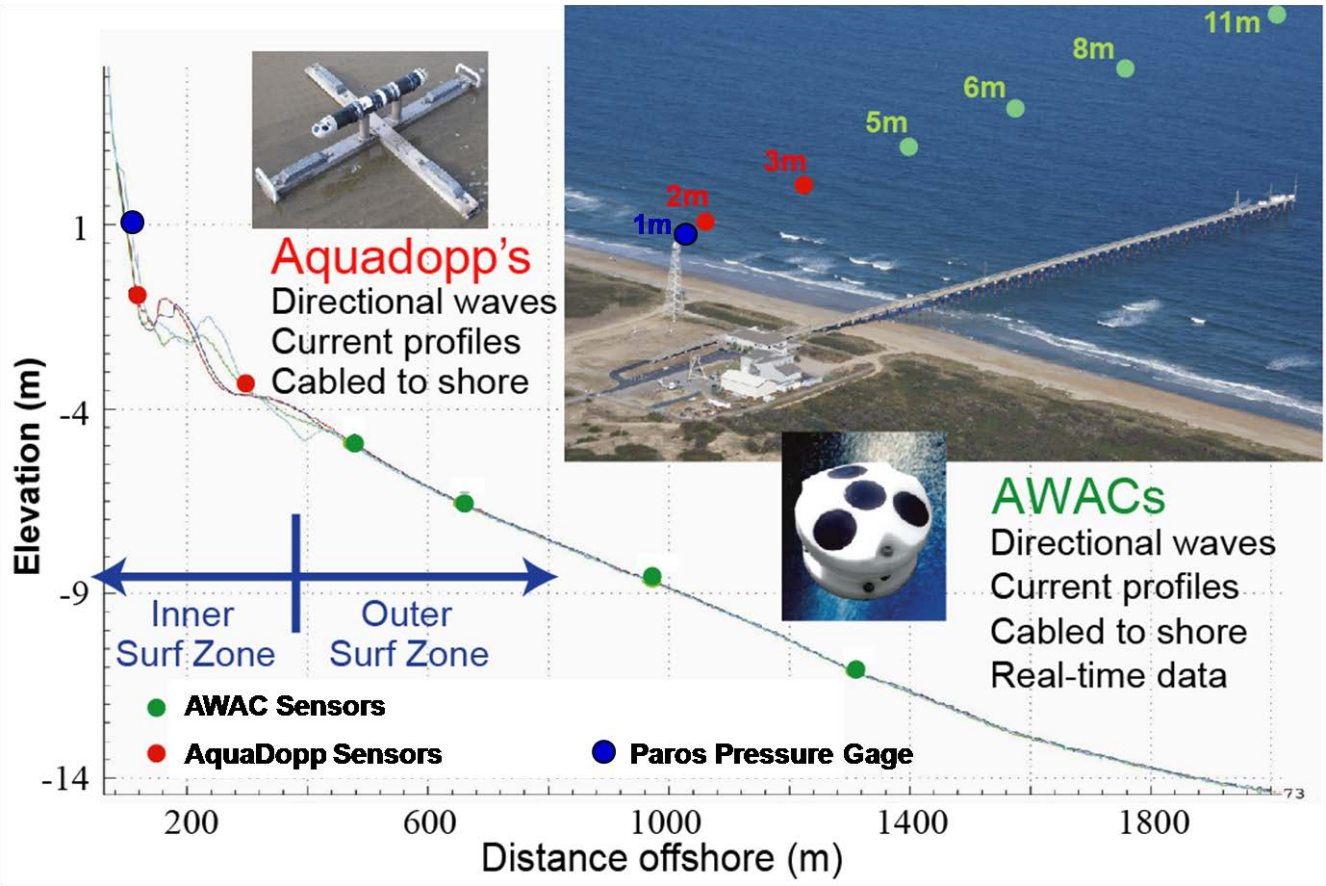

Figure 1. USACE FRF Nearshore wave and current array in Duck, NC. Scanning beach laser and offshore wave buoys not shown.

Model Improvements

USACE-FRF is working with WaveWatch III and SWAN developers at NOAA NCEP to implement (1) a wave partitioning capability in SWAN similar to what we previously provided for WaveWatch III, and (2) a spatial tracking capability that can be used in both models to track the space-time evolution of coherent wave systems in the model output. Once tested the resulting improvements are to be released as operational code.

Model validation.

USACE has developed the Interactive Model Evaluation and Diagnostics System (IMEDS) as a prototype GUI-driven toolbox to assess coastal process model performance using a variety of temporal and spatial metrics Hanson et al. (2009). As a diagnostic tool, IMEDS can be used to explore model errors and performance as a function of many variables (station, time, components, etc). Our approach is to transition the prototype IMEDS system into a robust model evaluation tool kit for community use. IMEDS will be split into 2 main components:

1. IMEDS desktop tool
2. IMEDS function library (MATLAB toolbox)

This phase of work focuses on improving existing capabilities (winds, waves, water levels and high water marks) and implementation of the IMEDS function library and the IMEDS Desktop tool. The system is designed such that follow-on work, including a web-based tool and addition of new parameters (currents, tides, beach profiles) can eventually be integrated into the architecture. To facilitate this development, USACE is providing in-kind support in the amount of $300,000 during FY11-14.

WORK COMPLETED

The major technical accomplishments for 2013 include:

Wave observations.

- Maintaining the Duck cross-shore wave and current array in operational status for 5+ years to date
- Time series data collections extended to 100-min to capture infragravity range
- Processing and posting data from 6 new cross-shore wave events to the NOPP validation data archive, for a total of 20 events to date including Hurricanes Earl, Bill, Ida, Kyle, Irene, Leslie and Sandy

Model Improvements

- Collaborating with NOAA/NCEP on improvements to wave system spatial tracking algorighm for WaveWatch III and SWAN.

Model validation.

- Directing the development of a professional GUI interface for IMEDS
- IMEDS II release to NOPP community scheduled for September 2013.

RESULTS

Wave observations.
We now have a 5-year near-continuous data set of wave transformation across the shelf and through the nearshore. Included are a large variety of events including several hurricanes, tropical storms and nor'easters. The 17-m Waverider wave height record, with key events annotated, appears in Figure 2.

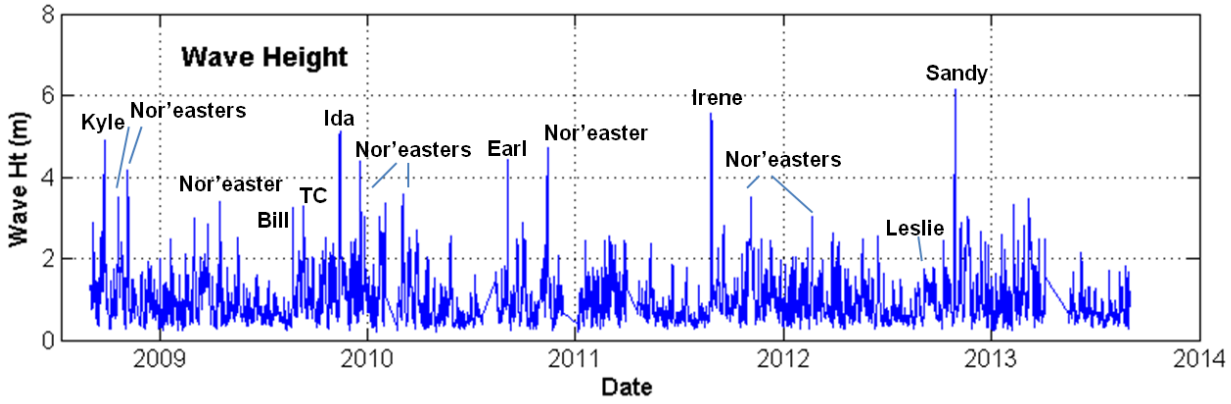

Figure 2. Sample wave height climatology (Aug 2008 – Sep 2013) from FRF 18-m Waverider station.

A set of unique cross-shore wave events has been processed and provided to the Waves NOPP validation data archive at NCEP. Care was taken to select events with a clear, distinctive wave signature ranging from pure wind sea events to pure swell events and including both offshore and onshore wind events. During FY13 we have added 6 new events including Hurricanes Leslie and Sandy. Table 1 provides a simmary of all events added to date. Note that peak significant wave heights range from 0.7-5.5 m with peak wave periods ranging frm 3-17.3 s. Event data includes meteorological forcing, waves (spectra and time series), current profiles, tides, and sea surface temperature. Furthermore, supporting bathymetry survey data and Argus imagery are available for download from the FRF web site (http://frf.usace.army.mil/).

IMPACT/APPLICATIONS

Due to the long-term operation of the Duck cross-shelf array (since late 2008), a variety of unique events, such as Hurricanes Ida, Irine and Sandy, have been collected. The resulting set of events is providing nearshore wave modelers with a rich set of information to improve numerical wave model source term performance in the challenging coastal environment.

RELATED PROJECTS

USACE Wave Information Studies (providing in-kind support for IMEDS)

Table 1. NOPP Wave Events from the USACE-FRF Cross-Shore Wave and Current Array

				Winds		Waves		
Event	**Type**	**Start** YYYYMMddhh	**Duration** (days)	**U10** (m/s)	**TWD** (from)	**Max *Hs*** (m)	***Tp*** (s)	**Description**
E1	Hurricane Earl	2010090205	2	24.0	N	4.5	8.5/15	Mixed sea and swell
E2	Hurricane Bill	2009082100	3	4.0	NW	3.6	17.3	Swell with harmonics
E3	Noreaster Ida	2009111112	6	14.9	NE	5.2	12.9	Wind sea
E4	Noreaster	2008101800	4	16.5	NNE	3.7	9-12 s	Wind sea
E5	Hurricane Kyle	2008092300	5	18.2	ENE	4.9	12.5	Mixed sea and swell
E6	Swell	2009032600	2	6.6	S	3.1	15.2	Swell, steady
E7	Swell	2009082715	4	5.0	variable	1.6	8-14	Swell, light winds
E8	Swell	2010082912	2	1.2	SSE	1.9	13.7	Swell
E9	Windsea	2009121900	2	12.0	ENE	4.3	10-11	Wind sea, shore parallel
E10	TS Hanna	2008090420	3	13.5	SE	2.8	7-12.5	Developing windsea over swell
E11	Fetch Limited	2010022600	1	12.0	W	0.7	3	Offshore winds, opposing swell
E12	Hurricane Irene	2011082600	5	29.0	NE-SE	5.5	16.3	Mixed sea and swell
E13	Slanting Fetch NW	2010122612	3	15.7	NNW	3.6	7.6	Wind sea to swell
E14	Slanting Fetch SW	2011042712	3	14.6	SSW	1.3	8.1	Wind Sea to swell
E15	Swell	2009021900	3	5.0	NE	2.0	11	Swell, light winds
E16	Slanting Fetch NW	2011110821	3	18.1	NNW	3.0	6-13	Wind sea to swell
E17	Mixed sea and swell	2012021919	3	8.0	NNE	1.8	14.0	Sea growth and decay with swell
E18	Hurricane Leslie	2012041812	7	Light	variable	1.7	12-16	Swell; Epic surfing event
E19	Hurricane Sandy	2012090319	6	22.2	NNW	6.0	16.3	Wind sea, NW slanting fetch
E20	Slanting Fetch NW	2012102600	2	17.2	NW	3.3	10.0	Wind sea event

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